Harding Lawson Associates

February 12, 1999

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Gary H. Yamamoto, P.E., Chief
California Department of Health Services
South Coastal Region
Drinking Water Field Operations Branch
1449 West Temple Street, Room 202
Los Angeles, CA 90026

Dear Mr. Yamamoto,

RESPONSES TO COMMENTS DATED JANUARY 22, 1999, REGARDING THE OCTOBER 29,1998 DRAFT, PHASE 2 TREATABILITY STUDY WORK PLAN, PILOT SCALE GROUNDWATER TREATMENT SYSTEM (BALDWIN PARK OPERABLE UNIT, SAN GABRIEL BASIN)

Harding Lawson Associates (HLA) has reviewed the January 22, 1999 comments provided by the Department of Health Services (DOHS) regarding the October 29, 1998 Draft Phase 2 Treatability Study Work Plan (Work Plan) and HLA's responses (dated January 13, 1999) to DOHS comments dated July 10, 1998 on the previous version of this work plan. HLA's responses to the DOHS comments dated January 22, 1999 are presented below. A revised work plan is also enclosed.

A general response regarding the comments is that the work plan is not intended as a protocol for the Phase 2 Treatability Study. Rather, it is intended to present the objectives of the Phase 2 Treatability Study and conceptual design of the Phase 2 treatment system. Specific information relative to how the study will be performed, what parameters will be adjusted, when and how samples will be collected, what analyses will be performed, and the decision criteria to be used in evaluating the results will be presented in the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP). The SAP and QAPP will be prepared and submitted for approval before beginning the Phase 2 Treatability Study.

RESPONSES TO SPECIFIC COMMENTS

1. ***Page 1-2: "Operation of the Phase 1 system identified operating parameters that can be used to achieve optimum system performance and established operating limits for these parameters.'***

   Page 3-5, "ORP data collected during Phase I indicated that an ORP of less than approximately -250 millivolts (mV) corresponded..."

   While there was some indication that it might be feasible to control the system with certain operating parameters, the work conducted under Phase 1 was not sufficient to establish these parameters as appropriate operating parameters nor was there sufficient work conducted to establish the operating

limits. The Department does not consider the work completed to date to be an adequate demonstration of these operating parameters.

Any demonstration of an operating parameter needs to include an actual demonstration of process failure (to operate in a mode that would create failure conditions with subsequent study to examine the recovery of the system).

Oxygen Reduction Potential (ORP) in the Phase 2 study should be monitored by an online instrument equipped with data acquisition capability and sufficient storage capacity for data collection.

Response: We agree that the Phase 1 study did not establish all operating limits. During the Phase 2 study, operating parameters will be further evaluated to establish these limits. The oxidation-reduction potential (ORP) in the Phase 2 study will be measured and recorded using on-line ORP probes located at several points in the biological system. Ethanol dosage will be set manually until it can be demonstrated that ORP can be effectively and reliably used as a control parameter.

2. ***Page 3-2 to 3-3. "The proposed mechanism... then to hypochlorite (OCL)..."***

The hypothesized mechanism for perchlorate destruction raises an interesting question. If this mechanism is correct, will there be, at some point in the operation of the reactor, sufficient hypochlorite (disinfectant) generation that will create a toxic environment, at a micro-scale, to the microorganisms present?

Response: Given that similar systems have been operated at much higher influent perchlorate concentrations (100-fold higher that expected during the Phase 2 study) with no apparent toxic effects. Therefore we do not anticipate a problem with hypochlorite toxicity in a system with such low perchlorate concentrations. If a problem is observed with maintaining the viability of the microorganism population, then a cause will be sought and the hypochlorite concentration will be considered.

3. ***Page 3-3: "Biological contact time and ethanol requirements will both increase..."***

The discussion regarding perchlorate destruction up to this point only discusses the reaction stoichiometry from an empirical perspective. The discussion does not refer to the reaction kinetics, which are important in the design and sizing of the biological reactors. The importance of biological contact time is noted in this statement, but it is not clear why the contact lime will increase with the higher dissolved oxygen concentration. Please expand this discussion.

It would also increase the confidence in the treatment process, if the Department could be assured by

demonstration, that perchlorate destruction was not just a consequence of nitrate reduction. That is, we would like to know if the perchlorate destruction is due to its conformational similarity to nitrate, and since the enzyme systems for reduction of nitrate are setup, the perchlorate is reduced concomitantly with the nitrate simply because it looks structurally similar to nitrate to the enzyme system. A portion of this question may be answered during the Phase 2 study. By examining operational parameters such as the food to microorganism ratio and nutrient concentrations (as suggested by the proposed reaction stoichiometry, nitrate also serves as nitrogen source for biosynthesis), we may be able to determine the impact of nitrate concentrations on the overall performance of this biological process.

Response: Required contact time will increase with higher dissolved oxygen because denitrification will not proceed until anoxic conditions exist. The total contact time required includes the contact time required to reduce oxygen plus the contact time required to reduce nitrate. With respect to reaction kinetics, a minimum mean cell residence time in the range of 1 to 5 days is typical for the denitrification process (Metcalf and Eddy, 1991, Table 11-20 and Equation 8-54).

We will examine operational parameters such as the F/M ratio, microorganism concentration, substrate utilization rate, and mean cell residence time during the Phase 2 Treatability Study. We do not plan to vary nitrate concentration. Testing perchlorate reduction in the absence of nitrate would be an interesting research project but is not applicable to the Phase 2 Treatability Study since initial work at the site suggests nitrate concentrations will be approximately 25 mg/L (as nitrate) and remain relatively consistent over time.

4. ***Page 3-4 to 3-5: "Optimum ethanol dosage was determined to be approximately 40 mg/L for... This concentration is approximately 43 percent higher than predicted by the empirical ethanol requirement equation..."***

The Department concurs that additional work will be required to optimize the ethanol dosage. However, the study should not be limited to only examining complete perchlorate and nitrate destruction. The study should also examine the impact of changing process conditions and water quality conditions on the unit process finished water. The effluent water quality conditions must be examined during and following any process parameter change and must be continued until the process reaches steady-state condition again. The study should use a five mean cell residence time as a rule of thumb to allow the process to reach to steady-state condition. Other values may be used if it can be demonstrated that steady-state conditions are met sooner.

Response: The suggested evaluations of the effects of changing process conditions and water quality conditions will be a part of the Phase 2 study. Using a typical mean cell residence time of 3 days (see response to Comment #3), approximately 15 days will be required to reach steady-state conditions after a change in process parameters. Actual mean cell residence time will be evaluated during the pilot study.

5. ***Page 4-4: "... the biological inoculum used to seed the growth of biomass will be characterized using plate count..."***

Standard bacterial plate counts will not be sufficient to identify human pathogens. Virus sample collection and analysis should be conducted on the inoculum. This should include enteric virus and bacteriophage enumeration. The variation of microorganism composition with time in the inoculum (the seed) and in the reactor (biomass) should be investigated. The frequency and number of samples should be based on the frequency of occurrence in the inoculum. The number of samples collected should be sufficient to ensure with 95% confidence that a difference of 10% could judge to be significant. The frequency of sampling should not be less than one-third the period of the shortest cycle so that sampling will be sufficient to characterize the shortest occurrence cycle. The protocol for the inoculum characterization should include standard bacteriological techniques to identify (to genus and species level) bacteria present in the reactor. Enteric viruses should also be typed.

Response: We agree that the inoculum and the biomass need to be sufficiently characterized to ensure the absence of human pathogens. The specific tests and frequency of testing will be included in the SAP. In addition to the proposed inoculum from a baby food plant, HLA is currently evaluating the possibility of using biomass from the existing bioreactors at the Rancho Cordova facility or using commercially available sources of bacteria for the inoculum.

Regardless of the source of the inoculum, adequate characterization of the inoculum and biomass will be performed to ensure the absence of human pathogens. We are confident that we can locate a source of inoculum that will be acceptable to everyone involved. If all proposed sources of inoculum are found to be unacceptable, HLA will attempt to establish a biomass without inoculation. This option is a last resort as it will require a significantly longer start-up period for the bioreactor.

For bacterial and virus testing, a preliminary list of analytical methods are listed in Table 8.1 of the Phase 2 Treatability Study Work Plan. The suggested decision criteria (95 percent confidence of detecting a 10 percent difference) will be used in designing a sampling program to evaluate the inoculum and biomass.

6. ***Page 5-3: UV/Oxidation***

This technology has not yet been approved for use as a mean of NDMA treatment. This technology needs to demonstrate the destruction or removal of NDMA. There are anecdotal reports that NDMA has been found in systems after UV/Oxidation and that it is unclear why and how the NDMA got through the UV/Oxidation process. Was the process incomplete in its destruction of NDMA (or NDMA precursors) allowing NDMA to reform in the distribution system? This remains an unknown

that needs to be explored.

Response: The UV/oxidation technology has been used to destroy NDMA for more than 5 years (Calgon, 1998). We do not anticipate any problems destroying NDMA with proper operation of the UV/oxidation system. The absorption of UV radiation is what causes the breakdown of NDMA; however, peroxide also absorbs UV radiation at a similar wavelength. One possibility for NDMA getting through a UV/oxidation system is that the oxidant dose is too high and too much of the UV light is absorbed by the oxidant, thereby inhibiting the NDMA destruction process. HLA recognizes this potential problem and will take it into consideration during the Phase 2 Treatability Study.

7. ***Page 6-4: "The Phase 2 Pilot System will include disinfection for a small portion (5 gpm) of the total flow to establish chlorine dose and required contact time...The study will include quantification of chlorine dose, chlorine contact time, CT10 calculation, chlorine residual..."***

   Page 6-7: "Optimum chlorine dose will be determined during pilot testing based on residual chlorine concentration."

   To a certain extent, the project is to demonstrate the efficacy of using biological treatment for the destruction of perchlorate. The optimum disinfectant concentrations could be based on the CT requirements or on the microbial water quality. The study must provide the Department with sufficient information on which of these parameters will control the inactivation.

   Note that a long pipe arranged in a serpentine fashion is proposed as a chlorine contact unit. For pipelines, it is usually assumed that all fluid passing through the pipe have a detention time equal to the theoretical residence time at a given flow rate. However, the proposed process diagram shows that the proposed sodium hypochlorite injection point is located in the pipeline prior to the contact unit without any mixing device. Given the small amount of flow to be studied, the chlorine feed pump must provide continuous and uniform feed stream so that the above assumption could be valid. Pulsing feed pumps should be avoided. Otherwise, the chlorine contact unit should be checked by tracer study to determine their true t10 values at given flows. In addition, the feasibility to provide for chloramination should be considered.

   Response: Residual chlorine concentrations and microbial water quality will both be evaluated to determine optimum chlorine dose. A continuous feed, constant rate pump and a static mixer will be used for chlorination.

8. ***Page 6-2: Operating parameters such as... MLSS will also be monitored and biological growth parameters such as mean cell residence time (sludge age), specific utilization rate, specific growth rate, and F/M ratio will be evaluated.***

In view of the attached growth nature of the GAC/FB bioreactor, the Department is interested in knowing where the sampling locations for MLSS measurement will be and how the mean cell residence time and F/M ratio will be evaluated. Does a plan to evaluate the specific utilization and growth rates exist?

Response: We understand that MLSS cannot be measured directly for an attached-growth process. To avoid this confusion, the term "MLSS" has been replaced with the term "microorganism concentration". A specific plan for measuring microorganism concentration will be detailed in the SAP but in general will involve taking representative grab samples from several locations in the bioreactor, gently shearing the biomass from the GAC in the samples, and measuring the resultant suspended solids. Mean cell residence time will be calculated using a similar protocol for measuring suspended solids in the biomass waste and the bioreactor effluent. F/M ratio and substrate utilization rate can then be calculated using the influent and effluent ethanol concentrations and the hydraulic residence time.

9. ***Page 6-2 to 6-3: Ethanol and phosphate amendments***

It appears that the feed rates of ethanol and phosphoric acid will be based on and controlled by the levels of the ORP in the reactor. If the feed rates are controlled by an ORP probe or any other device, a complete evaluation of the operation and maintenance (calibration requirements, calibration frequency, etc.) of the device, to ensure continuous and reliable operation, should be completed. In addition, the lag time between the dosage adjustment to the actual change in ORP level should be evaluated.

Response: Operation and maintenance procedures for the ORP probes will be included in the O&M plan. These procedures will include calibration requirements and calibration frequency. Lag time between dosage adjustment and change in ORP will be evaluated and used in programming the ORP-based dosage controller.

10. ***Section 6.4 Multimedia Filters***

To optimize filters performance, on-line particle monitors should be installed on the individual filters and the filter influent prior to polymer addition.

In addition, since the filter will be operated in biological mode, backwashing procedures should be optimized to ensure the maintenance of established microbial population subsequent to backwash events. Backwash turbidimeters should be installed for use on the individual filters to monitor solids release during backwash. Data acquisition and a storage device should be provided. The turbidity measurements should be verified by TSS, Total Coliform arid HPC samples during selected backwash cycles to determine optimal conditions.

Response: On-line particle monitors will be installed on each filter effluent line and on the filter influent prior to polymer addition. Backwash turbidimeters will be installed and used to control length of backwash. The procedures to be used for optimizing filter backwash will be detailed in the O&M plan and verification sampling for turbidity measurements will be included in the SAP.

11. ***Page 6-5: "Filter effluent for the first 10 minutes of each filter run will be discharged to the reclamation system holding tank for treatment in the reclamation system. Optimum filter-to-waste time will be determined during pilot testing based on measurement of filter effluent turbidity following backwash."***

This paragraph seems to contradict itself. The period of filter-to-waste should be based on turbidity readings, not time.

Response: Agreed. This section of the text has been modified as follows: "Optimum filter-to-waste time will be determined during pilot testing based on measurement of filter effluent turbidity following backwash"

12. ***Table 6-1 Preliminary Pilot System Design Criteria***

- *Recycle pump design criteria are missing in the GAC/FB Bioreactor Section.*
- *The sludge yield factor of 0.8 VSS/NO3 as N is a typical value of cell yield, Y, for the denitrification process as documented in literature. This factor is important for biomass control operation and the design of reclamation/solid handling system, therefore, should be verified. The Department recommends that sludge yield factor based on COD removed be evaluated.*
- *No data was provided for the biomass control system.*
- *In-line static mixer information is missing under Multimedia Filters Section.*
- *It appears that the flows from the reclaimed water recovery system were not accounted for in the sizing of the filters. The filters appear to be designed for 250 gpm each. Therefore, the hydraulic loading of the filter will exceed the target upper testing range of 8 gpm/ft2 when one of the filters is off-line during backwash.*

Response:

- **The recycle pump has been changed to the fluidization pump. The fluidization pump will pump both the influent flow and the recycle flow into the bioreactor whereas the recycle pump was pumping the recycle flow only. This change was made to provide consistent fluidization of the GAC media in the bioreactor. The fluidization pump will be designed to provide a flow rate of**

650 gpm to the bioreactor regardless of the plant influent flow rate (see modified Figure 5.1 in the work plan).

- **The sludge yield factor has been estimated based on published tables (Metcalf and Eddy, 1991). During the Phase 2 Treatability Study, the accuracy of the yield factor will be evaluated by comparing the actual quantity of sludge produced to the estimated quantity. If the actual quantity is greater than the estimated quantity, the filter press will need to be operated more often than expected. For example, if solids production is double the amount expected, the filter press will be run twice per day instead of once per day. Design of the lamella clarifier is based on conservative assumptions for the waste biomass flow rate, filter backwash flow rate and duration, filter run time, and filter-to-waste time. For example, the filter run time was assumed to be 24 hours, which we feel is a minimum, run time even if the solids load is significantly higher than expected. We feel that the design reclamation system flow rate of 40 gpm is conservative and will not increase even if solids production is higher than expected.**

- **The biomass control system is proprietary to the manufacturer of the bioreactor system and will be designed according to the manufacturers' recommendations. The system includes a submersible centrifugal pump, a growth control cone, and a waste biomass pump. The specific design criteria for the biomass control system will be developed with the manufacturer during final design.**

- **In-line static mixer information was not included in the Multimedia Filters section of the design criteria but was included in the text. An appropriate polymer mixer will be installed in the system. The details of the mixer will be included in the O&M Manual.**

- **The table has been updated to include flow from the reclamation system to the filters and exclude flow from the bioreactor to the reclamation system via the waste biomass line, resulting in a total flow rate to the filters of 531 gpm. The filters have been sized for a surface area of 65 square feet each, resulting in hydraulic loading rates of 4.1 gpm/sf if both filters are operating and 8.2 gpm/sf if one filter is operating. However, if the filter run time proves to be 48 hours instead of 24 hours, the total flow rate to the filters decreases to 515 gpm, resulting in hydraulic loading rates of 3.96 gpm/sf and 7.92 gpm/sf, respectively. If necessary, the plant influent flow rate will be reduced slightly so that the filter hydraulic loading rates are exactly 4.00 and 8.00 gpm/sf, respectively.**

General Comment: *With regard to the HLA's letter dated January 13, 1999, the response to the question raised on item number 3 is insufficient. It is the Department's view that testing for indicator organisms alone is inadequate for the identification of human pathogens. It is our understanding that the project team includes individuals with expertise in microbiology and significant experience with biological systems. These individuals should be consulted for what kinds of tests are necessary for the purpose of this project. At a minimum, the presence of regulated microorganisms and microorganisms listed in the EPA's Drinking Water Contaminant Candidate List should be investigated.*

Response: As mentioned in the response to Comment #5, the inoculum and the biomass will be sufficiently characterized to ensure the absence of human pathogens. HLA is currently evaluating alternative sources of bacteria for the inoculum. As a last resort, we will attempt to establish a biomass without inoculation. For bacterial and virus testing, a preliminary list of analytical methods is presented in Table 8.1 of the Work Plan. At a minimum, regulated microorganisms and microorganisms listed in the EPA's Drinking Water Contaminant Candidate List will be investigated. HLA has in-house microbiologists who will participate in the development of the SAP. In addition outside experts in this field will be consulted to ensure the characterization is comprehensive.

Should you have questions regarding these responses, please contact Jim Michael (303-293-6128) or John Catts (415-899-8825).

Sincerely,

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